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G3/38

DIODE
STEP STRESS PROGRAM

MSFC/NASA CONTRACT NUMBER
NAS8-31944

FINAL REPORT
FOR
JANTX1N5614

DECEMBER 1978

PREPARED FOR
GEORGE C. MARSHALL SPACE FLIGHT CENTER
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
MARSHALL SPACE FLIGHT CENTER, ALABAMA 35812



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FOREWORD

This report is a summary of the work performed on NASA Contract NAS8-31944. The investigation was conducted for the National Aeronautics And Space Administration, George C. Marshall Space Flight Center, Huntsville, Alabama. The Contracting Officer's Technical Representative was Mr. F. Villella.

The short-term objective of this preliminary study of transistors, diodes, and FETS is to evaluate the reliability of these discrete devices from different manufacturers, when subjected to power and temperature step stress tests.

The long-term objective is to gain more knowledge of accelerated stress testing for use in future testing of discrete devices, as well as, to determine which type of stress should be applied to a particular type device or design.

This report is divided as follows:
description of tests, figures, tables and appendix.



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1.0 INTRODUCTION/SCOPE

DCA Reliability Laboratory, under contract NAS8-31944 for NASA/Marshall Space Flight Center, has compiled data for the purpose of evaluating the effect of power/temperature step stress when applied to a variety of semiconductor devices. This report covers the switching diode JANTX1N5614 manufactured by Semtech and Micro Semiconductor.

A total of 48 samples from each manufacturer were submitted to the process outlined in Table 1. In addition, two control sample units were maintained for verification of the electrical parametric testing.

2.0 TEST REQUIREMENTS

2.1 Electrical

All test samples were subjected to the electrical tests outlined in Table 2 after completing the prior power/temperature step stress point. These tests were performed using the Fairchild Model 600 high-speed computer tester. Additional bench testing was also required on the devices.

2.2 Stress Circuit

The test circuit shown in Figure 1 was used to power all of the test devices during the power/temperature stress conditions. The voltage was set by V_F and the current was varied in order to comply with the specified power rating for this device. At least one of the devices was subjected to maximum rated power (MRP). All remaining devices were subjected to no less than 90% of MRP. See Figure 1 for load resistance values and voltages.



2.3 Group I - Power Stress

Thirty-two units, 16 from each manufacturer, were submitted to the power stress process. The diodes were stressed in 500-hour steps at 50, 100, 125, 150 and 175 percent of maximum rated power for a total of 2500 hours or until 50% or more of the devices in a sample lot failed*. Electrical measurements were performed on all specified electrical parameters after each power step. See Table 1.

2.4 Group II - Temperature Stress I

Thirty-two units, 16 from each manufacturer, were submitted to the temperature stress I process. Group II was subjected to a total of 1600 hours of stress at maximum rated power in increments of 160 hours. The temperature was increased in steps of 25°C, commencing at 75°C and terminating at 300°C or until 50% or more of the devices failed*. Electrical measurements were performed on all specified electrical parameters after each temperature step. See Table 1.

2.5 Group III - Temperature Stress II

Thirty-two units, 16 from each manufacturer, were submitted to the temperature stress II process. Group III was subjected to a total of 112 hours of stress at maximum rated power in increments of 16 hours. The temperature was increased in steps of 25°C, commencing at 150°C and terminating at 300°C or until 50% or more of the devices in a sample lot failed*. Electrical measurements were performed on all specified electrical parameters after each temperature step. See Table 1.

*Conditions for failure:

- A) Opens or shorts
- B) Leakage exceeds the maximum limit by 100 times
- C) Other parameters exceed MIL limits by 50 percent or greater



3.0 DISCUSSION OF TEST RESULTS

3.1 Group I - Power Stress

3.1.1 Semtech. The Semtech sample lot completed the entire 2500-hour Group I testing with one catastrophic failure. The failure occurred 25 hours into the 125% MRP step. Serial number 4619 failed because of excessive I_R leakage. Typical characteristics of this sample lot's performance were:

- 1) The mean value for I_R changed 26.49nA from an initial mean of 52.29nA to a final mean of 78.78nA.
- 2) The mean value for V_F changed .011V from an initial mean of 1.145V to a final mean of 1.156V.

The control units for this sample lot remained constant throughout the entire Group I testing.

3.1.2 Micro Semiconductor. The Micro Semiconductor sample lot completed a total of 1750 hours of Group I testing before the lot was stopped for having a 50% failure rate. The first failure occurred 500 hours into the 125% MRP step. Serial number 4663 failed because of excessive I_R leakage. The next four failures occurred 10 hours into the 150% MRP step. Serial numbers 4661, 4662, 4668 and 4669 failed because of excessive I_R leakages. The next failure occurred 25 hours into the 150% MRP step. Serial number 4666 failed because of excessive I_R leakage. The next failure occurred 150 hours into the 150% MRP step. Serial number 4664 was removed from the testing as a visual catastrophic failure because it broke in half



from the stress. The last failure occurred 250 hours into the 150% MRP step. Serial number 4665 was also removed as a visual catastrophic failure because it broke in half from the stress. Typical characteristics of this sample lot's performance were:

- 1) The mean value for I_R changed 1.249nA from an initial mean of 4.22nA to a final mean of 2.971nA.
- 2) The mean value for V_F changed 8.2mV from an initial mean of 980.7mV to a final mean of 988.9mV.

The control units for this sample lot remained constant throughout the entire Group I testing.

3.1.3 Statistical Summary - Group I. Table 4 outlines the results of Group I - Power Stress process for both electrical parameters and all measurement points for both Semtech and Micro Semiconductor.

3.2 Group II - Temperature Stress I

3.2.1 Semtech. The Semtech sample lot completed the entire 1600-hour Group II testing with no catastrophic failures. Typical characteristics of this sample lot's performance were:

- 1) The mean value for I_R changed 6.37nA from an initial mean of 47.56nA to a final mean of 41.19nA.
- 2) The mean value for V_F changed .015V from an initial mean of 1.136V to a final mean of 1.151V.

The control units for this sample lot remained constant throughout the entire Group II testing.



3.2.2 Micro Semiconductor. The Micro Semiconductor sample lot completed a total of 1120 hours of Group II testing before the lot was stopped for having a failure rate exceeding 50%. The first four failures occurred 160 hours into the 150°C-temperature step. Serial numbers 4677, 4683, 4686 and 4687 were removed from the testing as visual catastrophic failures because the anode leads detached from the stress. The next two failures occurred 160 hours into the 200°C-temperature step. Serial number 4674 was removed as a visual catastrophic failure because the anode lead detached from the stress. Serial number 4684 was removed as a visual catastrophic failure because the device broke in half from the stress. The last three failures occurred 160 hours into the 225°C-temperature step. Serial numbers 4675, 4682, and 4688 were removed as visual catastrophic failures because the anode leads detached from the stress. Typical characteristics of this sample lot's performance were:

- 1) The mean value for I_R changed 2.974 μ A from an initial mean of 3.744nA to a final mean of 2.978 μ A.
- 2) The mean value for V_F changed 9.7mV from an initial mean of 983.4mV to a final mean of 993.1mV.

The control units for this sample lot remained constant throughout the entire Group II testing.

3.2.3 Statistical Summary - Group II. Table 5 outlines the results of Group II temperature stress I testing for the two electrical parameters and all of the measurement points pertaining to both Semtech and Micro Semiconductor.



3.3 Group III - Temperature Stress II

3.3.1 Semtech. The Semtech sample lot completed the entire 112-hour Group III testing with no catastrophic failures. Typical characteristics of this sample lot's performance were:

- 1) The mean value for I_R changed 3.98nA from an initial mean of 43.77nA to a final mean of 47.75nA.
- 2) The mean value for V_F changed .01V from an initial mean of 1.153V to a final mean of 1.163V.

The control units for this sample lot remained constant throughout the entire Group III testing.

3.3.2 Micro Semiconductor. The Micro Semiconductor sample lot completed the entire 112-hour Group III testing with a total of eight catastrophic failures. The first failure occurred 16 hours into the 250°C-temperature step. Serial number 4700 was removed from the testing as a visual catastrophic failure because the device broke in half from the stress. Serial number 4705 was removed from the testing 16 hours into the 250°C-temperature step as a MIL-S-19500 limit failure. The next three failures occurred 16 hours into the 275°C-temperature step. Serial numbers 4689, 4696, and 4699 were removed from the testing as visual catastrophic failures because the anode leads detached from the stress. The last four failures occurred 16 hours into the 300°C-temperature step. Serial numbers 4691, 4692, and 4697 were removed from the testing as visual catastrophic failures because the anode leads detached from the stress. Serial number 4704 failed the minimum V_F limit. Typical



characteristics of this sample lot's performance were:

- 1) The mean value for I_R changed 125.34nA from an initial mean of 3.964nA to a final mean of 129.3nA.
- 2) The mean value for V_F changed 5.4mV from an initial mean of 989.4mV to a final mean of 994.8mV.

The control units for this sample lot remained constant throughout the entire Group III testing.

3.3.3 Statistical Summary - Group III. Table 6 outlines the results for Group III - Temperature Stress II testing for the two electrical parameters and all measurement points pertaining to both Semtech and Micro Semiconductor.

4.0 FINAL DATA SUMMARY

Table 7 statistically summarizes the change in the mean value from the zero-hour data to the final data. The graphs of Figures 2 and 4 plot the cumulative percent failures versus the temperature stress level for Group II - Temperature Stress I, and Group III - Temperature Stress II. The graphs of Figures 3 and 5 plot the time step for Group II (160 hours) and Group III (16 hours) versus the temperatures T_1 and T_2 calculated from Figures 2 and 4. Tables 8 and 9 summarize the failures encountered for all three stress groups. The failures are separated into two categories: catastrophic failures in Table 8 and parametric failures in Table 9. The data from Table 8 was used as a source for the graphs in Figures 2 and 4. Figures 2 and 4 were used as a source for the graphs in 3 and 5 respectively. Junction temperature is plotted on an inverse hyperbolic scale.

5.0 CONCLUSIONS

The Micro Semiconductor sample lot experienced an excessive amount of catastrophic failures in the Group I testing. The main failure mode was surface inversions which were caused by leakage of atmospheric moisture or other contaminants through the cracks in the glass.



The Group II and III testing showed the Semtech devices more durable than the Micro Semiconductor devices. Most of the Micro Semiconductor failures in these two test groups were visual due to an external lead detaching. The high temperatures of these tests were sufficient to crack the glass in a number of cases.

A plot showing cumulative failure distribution for Group II and Group III was drawn for the Micro Semiconductor sample lot (Figures 4 and 5), but a plot for the Semtech sample could not be drawn due to an absence of failure points in the Group II and Group III testing (Figures 2 and 3). Figures 4 and 5 display the data for the Micro Semiconductor sample lot used to calculate an activation energy of .91eV.

A broken circle around a marked point denotes a freak failure not calculated as part of the regression line. A solid circle around a marked point denotes an isolated failure point. The regression line was calculated using the least squares method.

The activation energy was calculated from the formula:

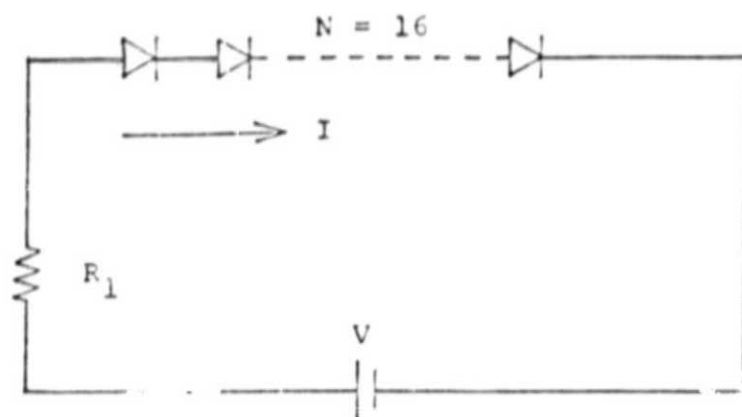
$$E = \left[\ln \left(\frac{t_1}{t_2} \right) \right] \left[\frac{8.63 \times 10^{-5} \text{ eV/}^\circ\text{K}}{\left(\frac{1}{T_1 + 273} \right) - \left(\frac{1}{T_2 + 273} \right)} \right] \text{ eV}$$

Where: t_1 = step of Group II - Temp Stress I = 160 hrs.

t_2 = step of Group III - Temp Stress II = 16 hrs.

T_1 = temperature in $^\circ\text{C}$ of 16% failure for Group II.

T_2 = temperature in $^\circ\text{C}$ of 16% failure for Group III.

SWITCHING DIODES

$$R_1 = 1V/I \pm 1\%$$

$$P_d = I E$$

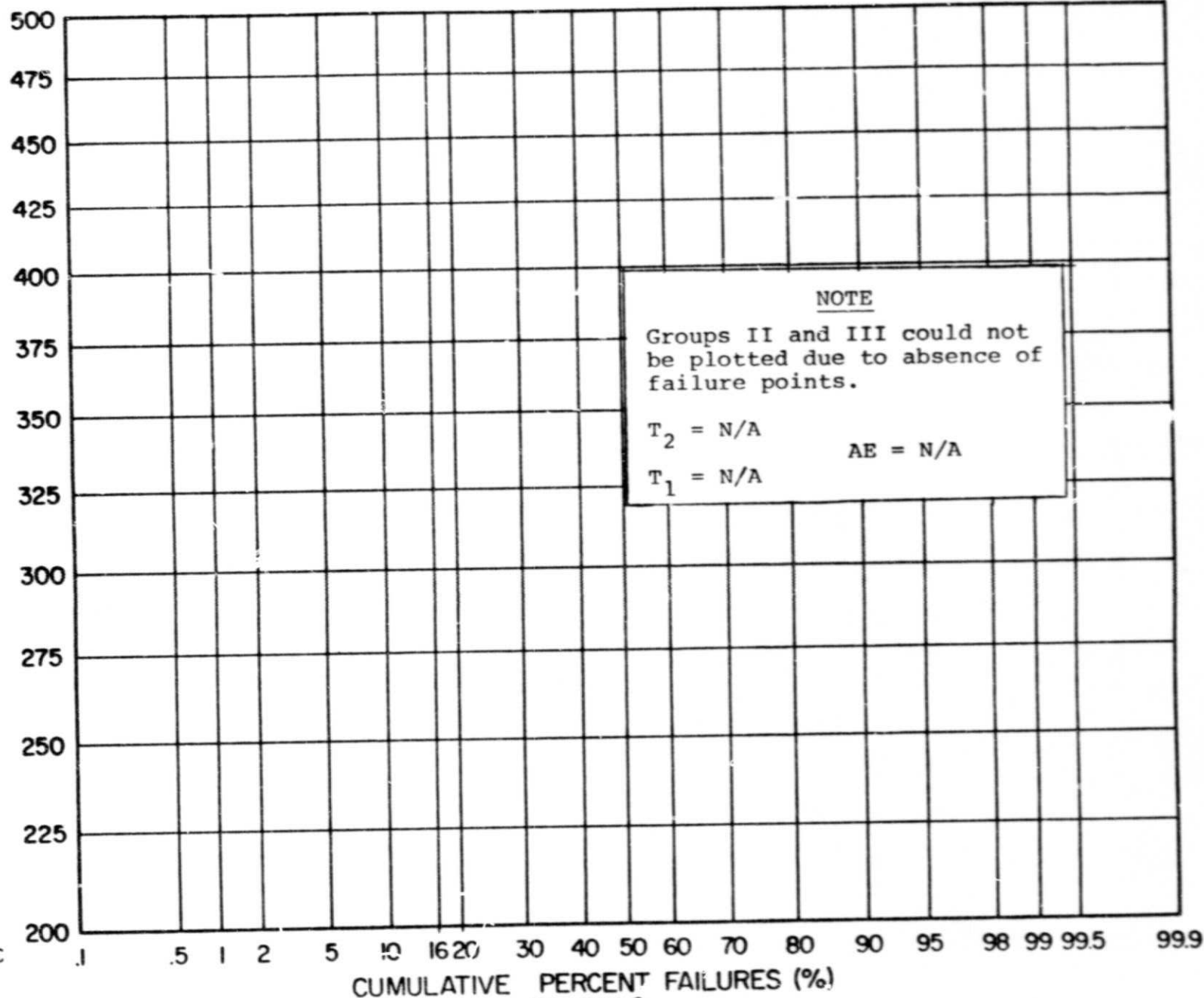
Figure 1 Power And Temperature Stress Circuit
For JANTX1N5614



SEMTECH

JAN 71 14

* JUNCTION TEMPERATURE (°C)



*NOTE

$$T_J \approx T_A + 175^\circ\text{C}$$

FIGURE 2

Cumulative Percent Failures Versus Junction Temperature, Semtech

JAN7X1N5614



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* JUNCTION TEMPERATURE (°C)

*NOTE

$$T_J \approx T_A + 175^\circ\text{C}$$

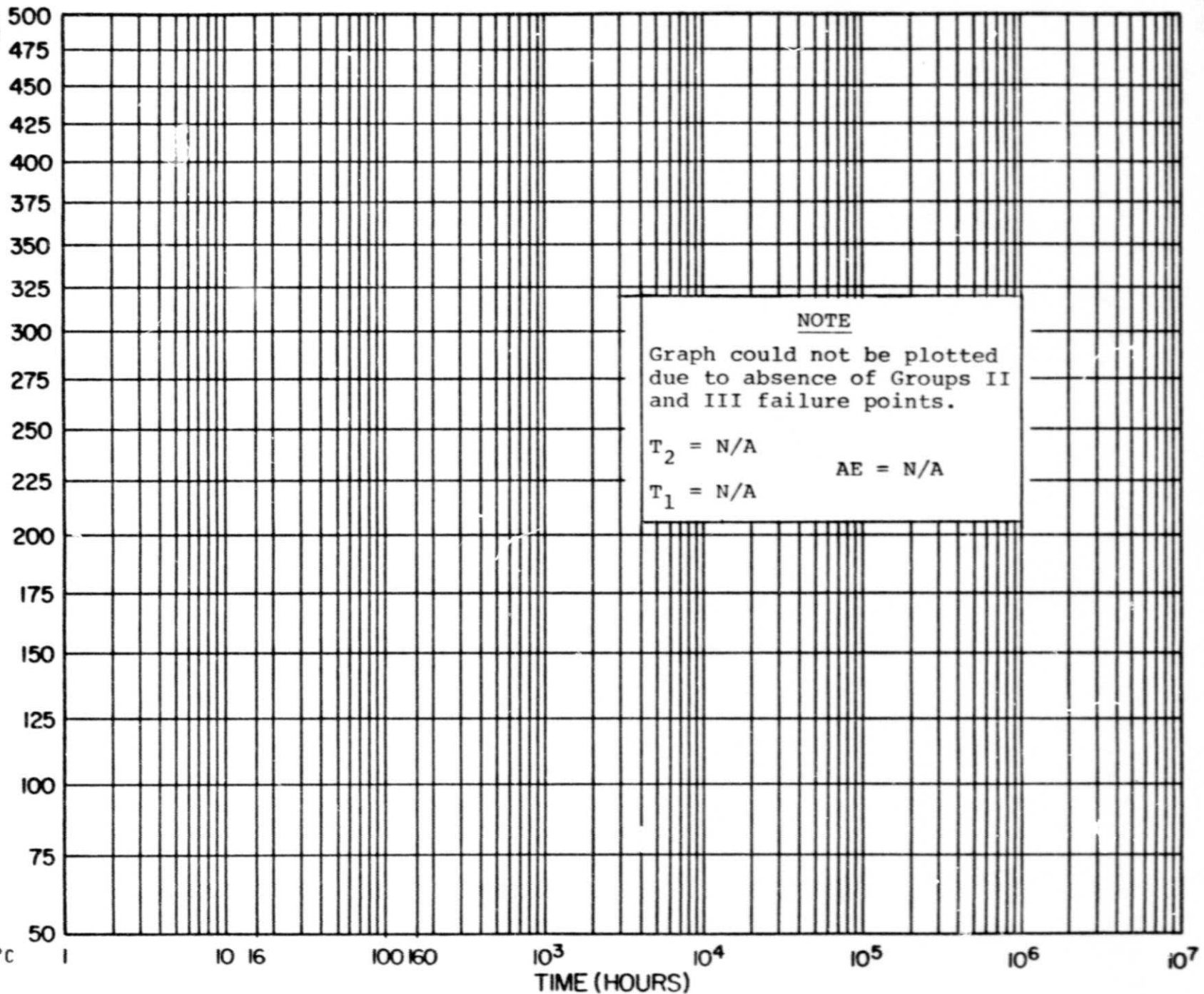


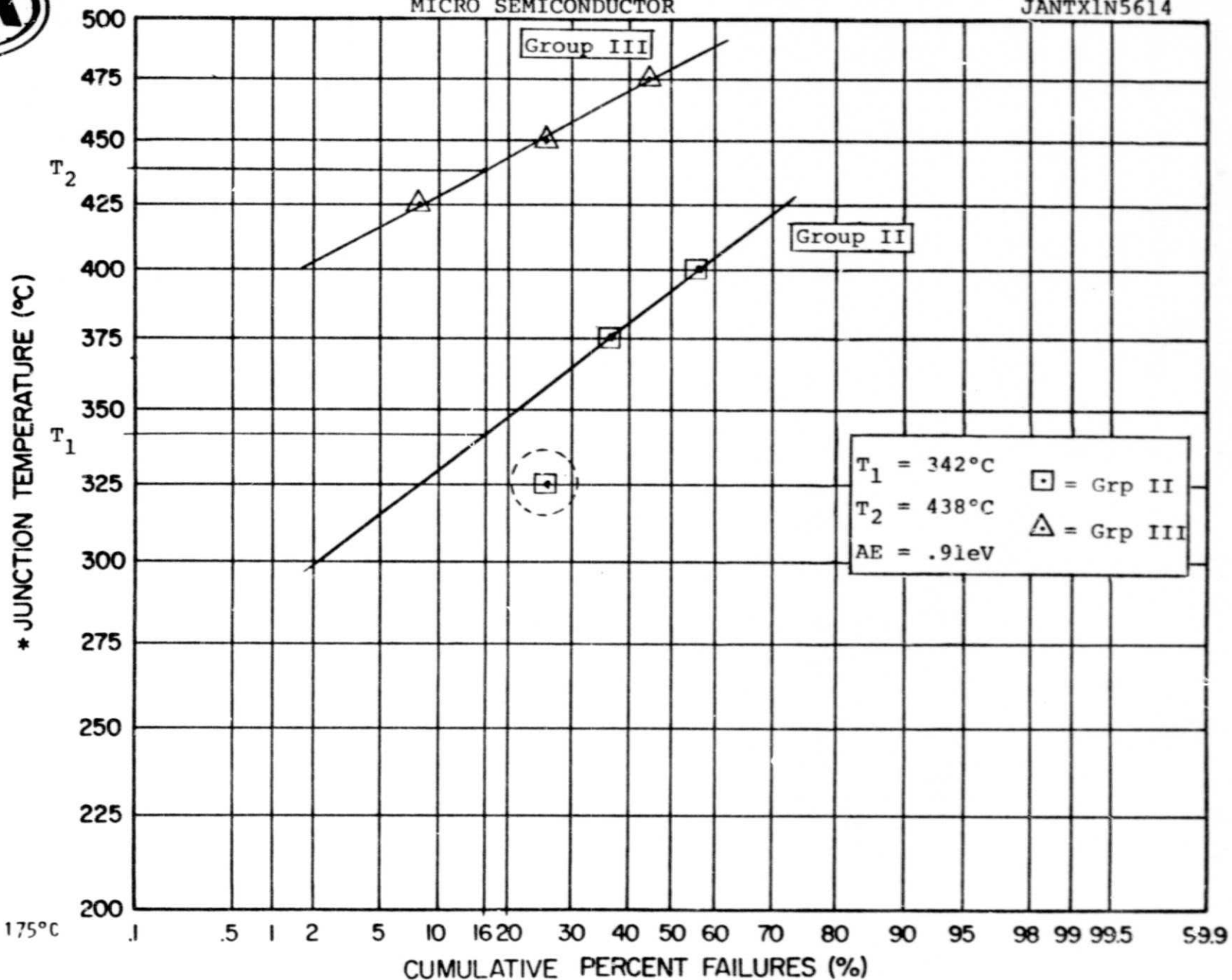
FIGURE 3

Time Steps Versus Junction Temperature, Semtech



MICRO SEMICONDUCTOR

JANTX1N5614



*NOTE

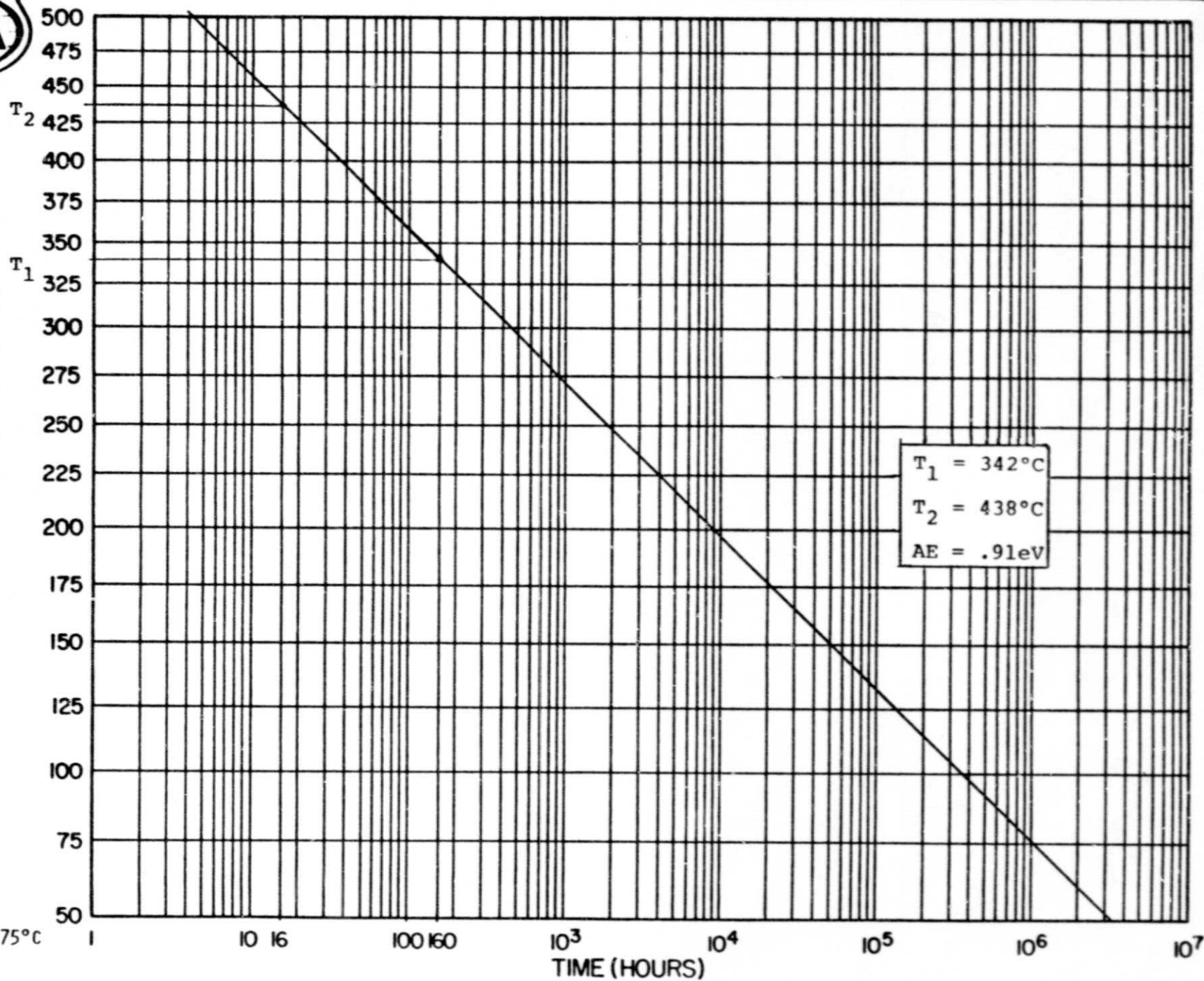
$$T_J \approx T_A + 175^\circ\text{C}$$

FIGURE 4

Cumulative Percent Failures Versus Junction Temperature, Micro Semiconductor



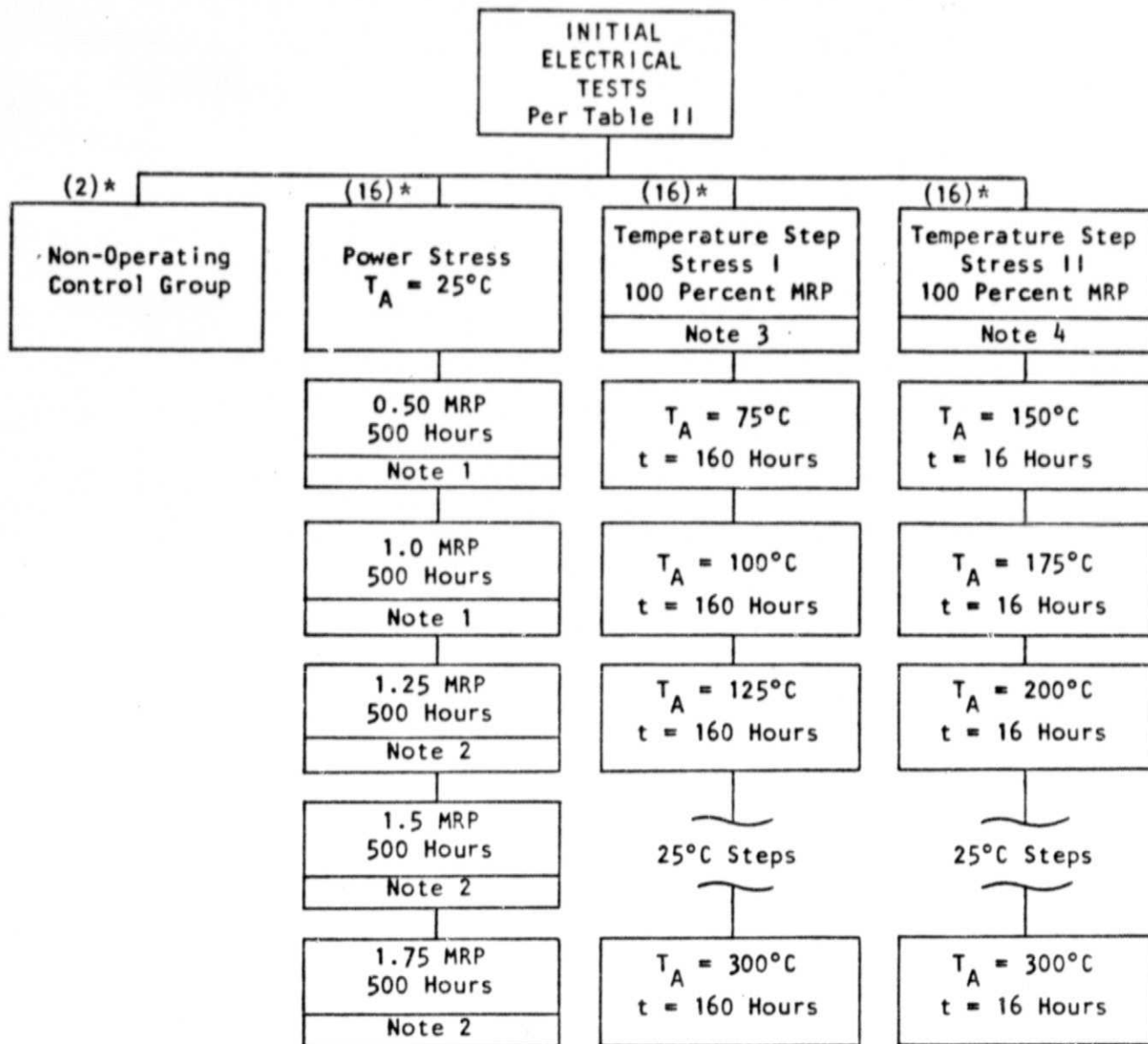
* JUNCTION TEMPERATURE (°C)



*NOTE

$$T_J \approx T_A + 175^\circ\text{C}$$

FIGURE 5
Time Steps Versus Junction Temperature, Micro Semiconductor

TABLE I
TEST FLOW DIAGRAM

*Quantity per manufacturer (Semtech & Micro Semiconductor)

NOTES:

- 1) Electrical measurements per Table II were made at 50, 150, 250 and 500 hours.
- 2) Electrical measurements per Table II were made at 10, 25, 50, 150, 250 and 500 hours.
- 3) Electrical measurements per Table II were made at the end of each 160 hours.
- 4) Electrical measurements per Table II were made at the end of each 16 hours.

TABLE II
PARAMETERS AND TEST CONDITIONS

PARAMETER	CONDITIONS	SPEC. LIMIT		CAT. LIMIT		UNITS
		MIN	MAX	MIN	MAX	
I_R	@ $V_R = 200V$		.5		50	μA
V_F	@ $I_F = 3.0A$ (Pulsed)	.8	1.3	.4	1.95	V(PK)

NOTES:

TABLE III
POWER STRESS BURN-IN CONDITIONS

$V_F = 1.0V$	
I_F	Percent P_D
.6A	50
1.2A	100
1.5A	125
1.8A	150
2.1A	175



NOTE
FOR TABLES
4 THROUGH 7

The minimum/maximum initial and final data generally have an absolute accuracy of $\pm 1\%$ of the reading and $\pm$ one digit except for readings greater than 9.99mA which have an absolute accuracy of $\pm 2\%$ of the reading and $\pm$ one digit. The data also has a resolution for four digits. The standard deviations, means, delta means, and average means are, therefore, valid indicators of trends over time and temperature, excepting the minor statistical computer error of supplying a constant number of significant digits.



TABLE 4
GROUP I - POWER STRESS DATA SUMMARY

Page 1 of 2

PARAMETER	$I_R = .5\mu A(\text{Max})$		$V_F = .8V(\text{Min})$ $1.3V(\text{Max})$					
CONDITIONS AND LIMIT	@ $V_R = 200V$		$I_F = 3.0A(\text{Pulsed})$					
IDENTIFICATION	SEM	MSC	SEM	MSC				
INITIAL DATA								
MIN VALUE	29.10nA	3.00nA	1.070V	972.0mV				
MAX VALUE	102.0nA	5.20nA	1.200V	996.9mV				
MEAN	52.29nA	4.22nA	1.145V	980.7mV				
STD DEV	18.61nA	.6853nA	.02828V	5.796mV				
INTERIM DATA								
POWER 50 TO 125% Δ MEAN VALUE								
50% POWER								
50 Hours	-1.03nA	-.429nA	-.001V	1.1mV				
150 Hours	-3.36nA	-.364nA	.003V	1.5mV				
250 Hours	1.42nA	-.624nA	.004V	2.6mV				
500 Hours	-1.78nA	-.659nA	.004V	2.6mV				
100% POWER								
550 Hours	-3.48nA	-.891nA	-.024V	-23.1mV				
650 Hours	-5.20nA	-.968nA	-.001V	1.3mV				
750 Hours	-2.07nA	1.401nA	-.010V	7.7mV				
1000 Hours	-5.20nA	-.968nA	-.001V	1.3mV				
125% POWER								
1010 Hours	*558.51nA	-1.357nA	.006V	4.6mV				
1025 Hours	1.65nA	-1.173nA	.011V	6.8mV				
1050 Hours	.95nA	-1.505nA	-.002V	5.5mV				
1150 Hours	-2.00nA	-1.379nA	.002V	6.3mV				
1250 Hours	5.60nA	34.89nA	-.005V	-20.3mV				
1500 Hours	9.18nA	6.454uA	-.017V	-18.3mV				

(continued on second sheet)



(continued from first sheet)

TABLE 4 (Cont'd)
GROUP I - POWER STRESS DATA SUMMARY

Page 2 of 2

PARAMETER	$I_R = .5\mu A(\text{Max})$		$V_F = .8V(\text{Min})$ $1.3V(\text{Max})$					
CONDITIONS AND LIMITS	@ $V_R = 200V$		@ $I_F = 2.0A(\text{Pulsed})$					
IDENTIFICATION	SEM	MSC	SEM	MSC				
INITIAL DATA								
MIN VALUE	29.10nA	3.00nA	1.070V	972.0mV				
MAX VALUE	102.00nA	5.20nA	1.200V	996.0mV				
MEAN	52.29nA	4.22nA	1.145V	980.7mV				
STD DEV	18.61nA	.6853nA	.02828V	5.796mV				
INTERIM DATA								
POWER 150 TO 175% Δ MEAN VALUE								
150% POWER								
1510 Hours	1.955uA	*907.40uA	.017V	7.1mV				
1525 Hours	5.30nA	*109.20uA	.015V	7.3mV				
1550 Hours	10.35nA	2.229uA	.016V	6.7mV				
1650 Hours	3.69nA	-1.517nA	.002V	2.1mV				
1750 Hours	15.84nA	-1.249nA	.017V	3.2mV				
2000 Hours	19.92nA	JobStopped	.019V	JobStopped				
175% POWER								
2010 Hours	17.80nA		.015V					
2025 Hours	17.22nA		.014V					
2050 Hours	18.40nA		.014V					
2150 Hours	18.97nA		.023V					
2250 Hours	18.67nA		.023V					
2500 Hours	26.49nA		.011V					
FINAL DATA								
MIN VALUE	44.20nA	2.320nA	1.070V	981.0mV				
MAX VALUE	150.00nA	3.460nA	1.200V	999.0mV				
MEAN	78.78nA	2.971nA	1.156V	988.9mV				
STD DEV	27.29nA	.3905nA	.03133V	6.47mV				

NOTE: Catastrophic Rejects removed from data after this point.

TABLE 5 GROUP II TEMP STRESS DATA SUMMARY

JANTX1N5614

PARAMETERS	$I_R = .5\mu A(\text{Max})$		$V_F = .8V(\text{Min}) 1.3V(\text{Max})$					
CONDITIONS AND LIMITS	$V_R = 200V$		$I_F = 3.0A(\text{Pulsed})$					
IDENTIFICATION	SEM	MSC	SEM	MSC				
INITIAL DATA								
MIN VALUE	26.40nA	2.930nA	1.090V	977.0mV				
MAX VALUE	78.80nA	5.210nA	1.180V	993.0mV				
MEAN	47.56nA	3.744nA	1.136V	983.4mV				
STD DEV	14.83nA	.6259nA	.02870V	5.373mV				
INTERIM DATA (INITIAL TO FINAL)								
Δ MEAN VALUE (T_A)								
160 Hours +75°C	2.56nA	-.774nA	.011V	6.4mV				
320 Hours +100°C	-3.30nA	-1.004nA	.015V	9.7mV				
480 Hours +125°C	2.34nA	-1.086nA	.018V	8.2mV				
640 Hours +150°C	1.23nA	183.66 nA	.020V	10.4mV				
800 Hours +175°C	5.65nA	* 1.214μA	.020V	9.1mV				
960 Hours +200°C	6.13nA	41.316nA	.020V	10.0mV				
1120 Hours +225°C	5.05nA	* 2.974μA	.018V	9.7mV				
1280 Hours +250°C	-.45nA	JobStopped	.020V	JobStopped				
1440 Hours +275°C	.36nA		.006V					
1600 Hours +300°C	-6.37nA		.015V					
FINAL DATA								
FINAL TEMP (T_A)	+300°C	+225°C	+300°C	+225°C				
MIN VALUE	18.60nA	1.960nA	1.090V	986.0mV				
MAX VALUE	92.30nA	16.60uA	1.230V	999.0mV				
MEAN	41.19nA	2.978uA	1.151V	993.1mV				
STD. DEV	19.12nA	5.628uA	.03551V	5.33mV				

NOTE: CATASTROPHIC REJECTS REMOVED FROM DATA AFTER THIS POINT.

JANTX1N5614

TABLE 6

GROUP III TEMP STRESS DATA SUMMARY

PARAMETERS	$I_R = .5\mu A(\text{Max})$		$V_F = .8V(\text{Min}) 1.3V(\text{Max})$					
CONDITIONS AND LIMITS	$V_R = 200V$		$I_F = 3.0A(\text{Pulsed})$					
IDENTIFICATION	SEM	MSC	SEM	MSC				
INITIAL DATA								
MIN VALUE	23.60nA	2.650nA	1.100V	980.0mV				
MAX VALUE	108.0nA	6.200nA	1.200V	1.040V				
MEAN	43.77nA	3.964nA	1.153V	989.4mV				
STD DEV	21.43nA	.9305nA	.02634V	14.17mV				
INTERIM DATA (INITIAL TO FINAL)								
Δ MEAN VALUE (T_A)								
16 Hours +150°C	5.37nA	.781nA	.003V	1.9mV				
32 Hours +175°C	3.13nA	.735nA	.001V	1.5mV				
48 Hours +200°C	7.95nA	.812nA	.008V	.5mV				
64 Hours +225°C	1.57nA	*465.54nA	.007V	6.8mV				
80 Hours +250°C	4.05nA	1.325nA	.000V	4.7mV				
96 Hours +275°C	10.09nA	9.866nA	-.010V	-2.2mV				
112 Hours +300°C	3.98nA	*125.34nA	.010V	5.4mV				
FINAL DATA								
FINAL TEMP (T_A)	+300°C	+300°C	+300°C	+300°C				
MIN VALUE	22.90nA	4.110nA	1.110V	976.0mV				
MAX VALUE	152.0nA	999.0nA	1.210V	1.050V				
MEAN	47.75nA	129.3nA	1.163V	994.8mV				
STD DEV	30.11nA	328.7nA	.02663V	22.09mV				

NOTE: CATASTROPHIC REJECTS REMOVED FROM DATA AFTER THIS POINT.



JANTX1N5614

TABLE 7
FINAL DATA SUMMARY

PARAMETER	SPECIFICATIONS LIMIT		U N I T S	MEAN INT. DATA	AVERAGE Δ IN MEAN VALUE					
	MIN	MAX			POWER STRESS		TEMPERATURE STRESS I		TEMPERATURE STRESS II	
					SEM	MSC	SEM	MSC	SEM	MSC
I _R	-	.5	uA		+.10311	*+53.963	+.00132	+.63002	+.00112	+.08530
V _F	.8	1.3	V		+.00673	+.00058	+.01630	+.00907	+.00271	+.00266

NOTE: Catastrophic reject(s) removed from data after this point.

JANTX1N5614



TABLE 8 STEP STRESS CATASTROPHIC FAILURE SUMMARY

JAN TX1N5614

GROUP I POWER STRESS

TEST STEP	MFR A		MFR B	
	QTY.	NOTE	QTY.	NOTE
50% 50 hr.	0	-	0	-
100 hr.	0	-	0	-
100 hr.	0	-	0	-
250 hr.	0	-	0	-
100% 50 hr.	0	-	0	-
100 hr.	0	-	0	-
100 hr.	0	-	0	-
250 hr.	0	-	0	-
125% 10 hr.	0	-	0	-
15 hr.	1	A	0	-
25 hr.	0	-	0	-
100 hr.	0	-	0	-
100 hr.	0	-	0	-
250 hr.	0	-	1	A
150% 10 hr.	0	-	4	A
15 hr.	0	-	1	A
25 hr.	0	-	0	-
100 hr.	0	-	1	B
100 hr.	0	-	1	B
250 hr.	0	-	Job Stopped	
175% 10 hr.	0	-		
15 hr.	0	-		
25 hr.	0	-		
100 hr.	0	-		
100 hr.	0	-		
250 hr.	0	-		

GROUP II 160 HR. TEMP. STEPS

TEST STEP (T _A)	MFR A		MFR B	
	QTY.	NOTE	QTY.	NOTE
75°C	0	-	0	
100°C	0	-	0	
125°C	0	-	0	
150°C	0	-	4	C
175°C	0	-	0	-
200°C	0	-	1 1	B C
225°C	0	-	3	C
250°C	0	-	Job Stopped	
275°C	0	-		
300°C	0	-		

GROUP III 16 HR. TEMP. STEPS

TEST STEP (T _A)	MFR A		MFR B	
	QTY.	NOTE	QTY.	NOTE
150°C	0	-	0	-
175°C	0	-	0	-
200°C	0	-	0	-
225°C	0	-	0	-
250°C	0	-	1	B
275°C	0	-	3	C
300°C	0	-	3 1	C D

MFR "A" = SEMTECH

MFR "B" = MICRO SEMICONDUCTOR

NOTES:

- A. $I_R > 50 \mu A$
- B. VISUAL (BROKEN IN HALF)
- C. VISUAL (ANODE LEAD DETACHED)
- D. $V_F < .4V$



TABLE 9 STEP STRESS PARAMETRIC FAILURE SUMMARY

JAN TX1N5C14

GROUP I POWER STRESS

TEST STEP	MFR A		MFR B	
	QTY.	NOTE	QTY.	NOTE
50% 50 hr.	0	-	0	-
100 hr.	0	-	0	-
100 hr.	0	-	0	-
250 hr.	0	-	0	-
100% 50 hr.	0	-	0	-
100 hr.	0	-	0	-
100 hr.	0	-	0	-
250 hr.	0	-	0	-
125% 10 hr.	1	A	0	-
15 hr.	0	-	0	-
25 hr.	0	-	0	-
100 hr.	0	-	0	-
100 hr.	0	-	0	-
250 hr.	1	B	2	A
150% 10 hr.	1	A	0	-
15 hr.	0	-	0	-
25 hr.	0	-	1	A
100 hr.	0	-	0	-
100 hr.	0	-	0	-
250 hr.	0	-	Job Stopped	
175% 10 hr.	0	-		
15 hr.	0	-		
25 hr.	0	-		
100 hr.	0	-		
100 hr.	0	-		
250 hr.	0	-		

GROUP II 160 HR. TEMP. STEPS

TEST STEP (T _A)	MFR A		MFR B	
	QTY.	NOTE	QTY.	NOTE
75°C	0	-	0	-
100°C	0	-	0	-
125°C	0	-	0	-
150°C	0	-	1	A
175°C	0	-	1	A
200°C	0	-	0	-
225°C	0	-	2	A
250°C	0	-	Job Stopped	
275°C	0	-		
300°C	0	-		

GROUP III 16 HR. TEMP. STEPS

TEST STEP (T _A)	MFR A		MFR B	
	QTY.	NOTE	QTY.	NOTE
150°C	0	-	0	-
175°C	0	-	0	-
200°C	0	-	0	-
225°C	0	-	1	A
250°C	0	-	1	C
275°C	0	-	0	-
300°C	0	-	0	-

MFR "A" = SEMTECH

MFR "B" = MICRO SEMICONDUCTOR

NOTES:

- I_R MAXIMUM LIMIT FAILURE
- S/N 4614 MISSING FROM SAMPLE LOT @ MP-15
- S/N 4705 REMOVED FROM TESTING AS A MIL-S-19500 LIMIT FAILURE



APPENDIX

FAILURE ANALYSIS



FAILURE ANALYSIS

JANTX1N5614

Date 3 October 1978

J/N 2CN242-24B P/N 1N5614 MFR Micro-Semiconductor

FAILURE VERIFICATION: Limit: Limits:
50uA Max 0.4-1.95V

S/N	PIV Volts		I_R @ 200V.dc	V_f @ 3.0A.dc			Initial Rej. @ Test Seq. No.:	Initial Rej. for
4674	430		10nA	1.04V			13(200°C)	Visual
4677	420		100nA	1.00V			09(150°C)	Visual
4684	4.0R		*50uA	100mV			12(200°C)	Visual
			*Cannot reach 200V. Die is broken.					

INTERNAL VISUAL INSPECTION:

The three samples have missing external leads. In addition S/N 4677 has missing glass at the anode end. Three other rejected samples not selected for this analysis also have missing glass. S/N 4684 is broken in half and the die has fractured with one half remaining on each heat sink. See Figures A-1 and A-2.

CONCLUSIONS:

High Temperatures were sufficient to crack the glass. Thermal stress was responsible for the extensive physical destruction of S/N 4684.

It is not known why the damage was preferential to the anode end of the devices. One possible explanation might be better heat sinking of the cathode ends in the oven racks.

*h_{FE} trace present. Cannot meet stated test conditions. (Leaky)
**h_{FE} trace very leaky.

D = drift H = hysteresis Inv = inversion R = resistive S = soft Uns = unstable



JANTX1N5614



FIGURE A-1
S/N 4677 Micro-Semiconductor, 21X Sample.
Note missing anode lead and cracked glass.



FIGURE A-2
S/N 4684 Micro-Semiconductor, 13X Sample.
Note broken glass and die.

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FAILURE ANALYSIS

JANTX1N5614

Date 4 October 1978

J/N 2CN242-24A P/N 1N5614 MFR Micro-Semiconductor

FAILURE VERIFICATION:

Limit: 50uA Max Limits: 0.4 to 1.95V

S/N	Volts	I_R @ 200V.dc	V_f @ 3.0A.dc	Initial Rej. @ Test Seq. No.:	Initial Rej. for:
4663	*	>50uA;D;Inv	1.12	29	I_R
4666	*	>50uA;D;Inv	1.00	33	I_R
4668	*	>50uA;D;Inv	1.00	29	I_R
*Cannot reach 200V or PIV due to high leakage.					

VISUAL INSPECTION:

All three samples have cracked glass. No other significant anomalies were seen.

HERMETICITY:

S/N 4663 and 4666 are gross leakers; S/N 4668 fails fine leak.

CONCLUSION:

These samples failed due to surface inversions which were caused by leakage of atmospheric moisture or other contaminants through the cracks in the glass.

*h_{FE} trace present. Cannot meet stated test conditions. (Leaky)

**h_{FE} trace very leaky.

D = drift H = hysteresis Inv = inversion R = resistive S = soft Uns = unstable

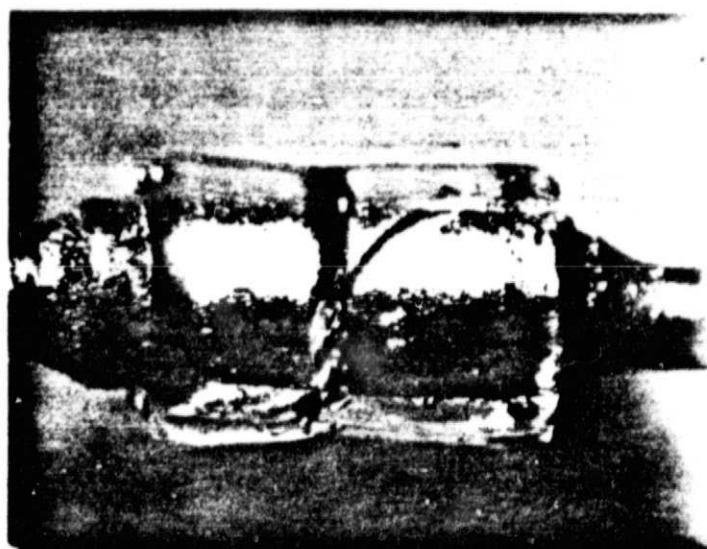


FIGURE A-3
S/N 4666 Typical failed Micro-Semiconductor,
18X Sample. Note cracked glass.

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FAILURE ANALYSIS

JANTX1N5614

Date 4 May 1978

J/N 2CN242-24C P/N 1N5614 MFR Micro-Semiconductor

FAILURE VERIFICATION:

Limits: Limits:
0.5uA 1.05±.25

S/N	PIV Volts		I_r @ 200V.dc	V_f @ 3.0A.dc			Initial Rej. @ Test Seq. No.:	Initial Rej. for:
4700	Broken	cannot test.						
4704	420		(70uA in light)	1.2				
4705	380 inv;D		17uA;D;inv	1.0			(as received)	
4705	380 hard		0.2uA	-			(after 2 min 100°C bake)	

VISUAL INSPECTION:

S/N 4700 has broken into 2 parts at the die. Part of this die is attached to each heat sink. The glass is shattered. (See Figure A-4).

All external leads are oxidized.

S/N 4704 has lost all its paint except for a narrow band of white residue around the cooler mid-line of the diode. The other samples still have dark paint.

PAINT CONDUCTIVITY TEST:

The resistivity of the paint across a diameter of the diodes is greater than 20 megohms and is not a problem.

HERMETICITY:

S/N 4705 was tested for gross leaks. A small leak was found at each end. Removing the paint revealed cracked glass. (See Figure A-5).

CONCLUSIONS:

Of these 16 Micro Semiconductor samples, 6 lost an external lead and 3 had cracked glass (2 analyzed). Examination of a few un-cracked diodes with polarized light revealed areas of high tension and compression in the glass bodies, particularly over the heat sinks.

(Continued)

*h_{FE} trace present. Cannot meet stated test conditions. (Leaky)

**h_{FE} trace very leaky.

D = drift H = hysteresis Inv = inversion R = resistive S = soft Uns = unstable

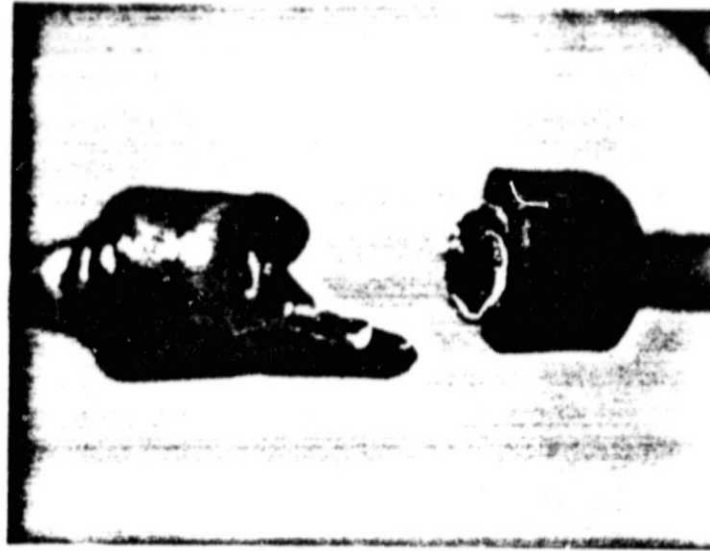


FIGURE A-4
S/N 4700 Micro-Semiconductor, 12X Sample.
Note broken glass and die after burn-in.

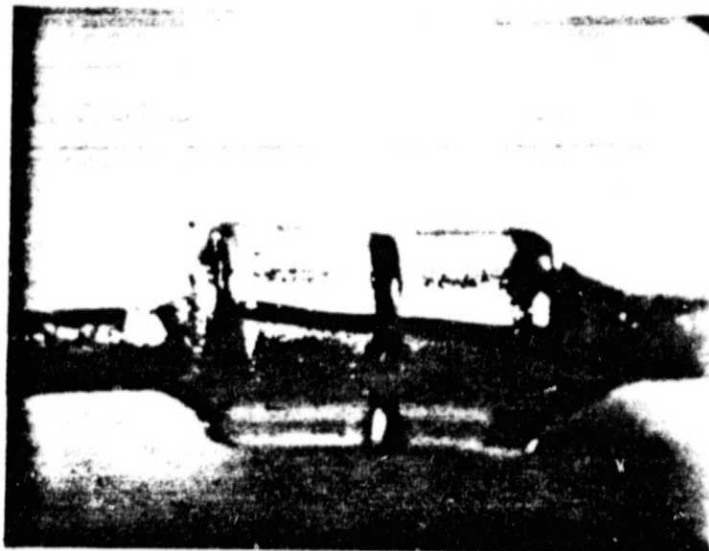


FIGURE A-5
S/N 4705 Micro-Semiconductor, 13X Sample.
Cracked glass revealed after removing paint.

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